METHOD FOR CONTROLLING COOLING/HEATING OF HEAT PUMP SYSTEM

BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to a heat pump system selectively operated in a cooling/heating mode, and more particularly to a method for controlling cooling/heating of a heat pump system, in which noise generated by flow of a refrigerant is reduced when the system is switched between cooling/heating modes.

Description of the Related Art

Fig. 1 is a schematic view of a conventional heat pump system.

As shown in Fig. 1, the conventional heat pump system, operated in a heating mode, comprises a compressor 2 for compressing a refrigerant into a high-temperature and high-pressure gaseous state, an indoor heat exchanger 4 for condensing the refrigerant passing through the compressor 2 into a medium-temperature and high-pressure liquid state, an electronic expansion valve 6 for decompressing the refrigerant passing through the indoor exchanger 4 into a low-temperature and low-pressure liquid state, an outdoor heat exchanger 8 for

evaporating the refrigerant passing through the electronic expansion valve 6 into a low-temperature and low-pressure gaseous state, an accumulator 10 connected to an inlet of the compressor 2 for filtering the liquid refrigerant, and a four-way valve 12 connected to an outlet of the compressor 2 for changing the flow direction of the refrigerant in accordance with cooling and heating modes. Operation of such a heat pump system is controlled by a control unit.

In the heating mode of the heat pump system, the refrigerant circulates along the compressor 2, the indoor heat exchanger 4, the electronic expansion valve 6 and the outdoor heat exchanger 8, sequentially. The indoor heat exchanger 4 and the outdoor heat exchanger 8 serve as a condenser and an evaporator, respectively. On the other hand, in a cooling mode of the heat pump system, the refrigerant circulates along the compressor 2, the outdoor heat exchanger 8, the electronic expansion valve 6 and the indoor heat exchanger 4, sequentially, in the opposite direction of the heating mode. Here, the indoor heat exchanger 4 and the outdoor heat exchanger 8 serve as an evaporator and a condenser, respectively.

In case that the heat pump system in the heating or cooling mode is switched to the other mode, or the heat pump system in the heating mode is operated in a defrosting mode, the four-way valve 12 is operated so as to change the flow

direction of the refrigerant.

Fig. 2 illustrates graphs respectively showing power supply states provided to the compressor 2 and the four-way valve 12 when a cooling/heating mode is switched in the conventional heat pump system.

In the cooling/heating mode switching of the above conventional heat pump system, as shown in Fig. 2, power is continuously supplied to the compressor 2, but a power supply to the four-way valve 12 is changed from an on state to an off state. Of course, the power supply to the four-way valve 12 may be changed from the off state to the on state.

Accordingly, since the compressor 2 is continuously operated, the refrigerant continuously flows. Under the condition that the refrigerant flows, the four-way valve 12 is switched so as to change the flow direction of the refrigerant.

Since the four-way valve 12 is switched so as to change the flow direction of the refrigerant under the condition that the refrigerant flows, the rapid change of the flow direction of the refrigerant in the conventional heat pump system causes noise generated by the flow of the refrigerant.

SUMMARY OF THE INVENTION

Therefore, the present invention has been made in view of the above problems, and it is an object of the present

invention to provide a method for controlling cooling/heating of a heat pump system, in which a four-way valve is operated so as to change a flow direction of a refrigerant under the condition that flow of the refrigerant has a reduced speed or is stopped, thus reducing noise generated by a sudden change of the flow direction of the refrigerant.

In accordance with the present invention, the above and other objects can be accomplished by the provision of a method for controlling cooling/heating of a heat pump system, comprising the steps of: (a) controlling a compressor so that a flow rate of a refrigerant is reduced when the heat pump system is switched from a cooling mode to a heating mode or from the heating mode to the cooling mode; and (b) controlling a four-way valve so that a flow direction of the refrigerant is changed into an opposite direction when the flow rate of the refrigerant after the step (a) is reduced.

Preferably, a power supply to the compressor may be switched off in the step (a) so that the flow rate of the refrigerant is reduced, and a power supply to the compressor may be switched on after the step (b).

Alternatively, the operation of the compressor may be converted into a stage having a lower state than that of a stage at a point of time when the heat pump system is switched from the cooling mode to the heating mode or from the heating mode to the cooling mode so that the flow rate of the

refrigerant is reduced. The method may further comprise the step of (c) controlling the compressor to re-operate in a normal state after the step (b).

Preferably, the four-way valve in the step (b) may be controlled to convert the flow direction of the refrigerant into the opposite direction, in case that a designated time from the step (a) elapses.

Otherwise, the four-way valve in the step (b) may be controlled to convert the flow direction of the refrigerant into the opposite direction, in case that the flow rate of the refrigerant is reduced to less than a designated rate.

Otherwise, the four-way valve in the step (b) may be controlled to convert the flow direction of the refrigerant into the opposite direction, in case that the flow rate of the refrigerant reaches zero (0).

Further, preferably, the four-way valve in the step (b) may be controlled such that power is supplied to the four-way valve when the heat pump system is switched from the cooling mode to the heating mode, and a power supply to the four-way valve is cut off when the heat pump system is switched from the heating mode to the cooling mode.

The method of the present invention stops the compressor so that flow of the refrigerant is reduced or stopped when a mode of the heat pump system is switched from the cooling mode to the heating mode or from the heating mode to the cooling

mode, and controls the four-way valve to change the flow direction of the refrigerant after the designated time from the stoppage of the compressor elapses, thus preventing the rapid change of the flow direction of the refrigerant and reducing noise generated in the cooling/heating mode switching. Accordingly, it is possible to increase reliability of heat pump system products.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a schematic view of a conventional heat pump system;

Fig. 2 illustrates graphs respectively showing power supply states provided to a compressor and a four-way valve when a cooling/heating mode is switched in the conventional heat pump system;

Fig. 3 is a flow chart illustrating a method for controlling cooling/heating of a heat pump system in accordance with the present invention;

Fig. 4 illustrates graphs respectively showing power supply states provided to a compressor and a four-way valve

when a heating mode is switched to a cooling mode in the heat pump system in accordance with the present invention; and

Fig. 5 illustrates graphs respectively showing power supply states provided to the compressor and the four-way valve when the cooling mode is switched to the heating mode in the heat pump system in accordance with the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now, preferred embodiments of the present invention will be described in detail with reference to the annexed drawings.

Fig. 3 is a flow chart illustrating a method for controlling cooling/heating of a heat pump system in accordance with the present invention.

Hereinafter, an embodiment of the method for controlling cooling/heating of the heat pump system, i.e., a method for controlling switching from a heating mode to a cooling mode, will be described with reference to Figs. 1 and 3.

As shown in Fig. 3, the compressor 2 is operated so that the heat pump system is operated in a heating mode (S1).

Here, as shown in Fig. 1, the refrigerant circulates along the compressor 2, the indoor heat exchanger 4, the electronic expansion valve 6 and the outdoor heat exchanger 8, sequentially. The indoor heat exchanger 4 serves as a condenser for condensing the refrigerant into a medium-

temperature and high-pressure liquid state by heat-exchanging the refrigerant with indoor air, and the outdoor heat exchanger 8 serves as an evaporator for evaporating the refrigerant into a low-temperature and low-pressure gaseous state by heat-exchanging the refrigerant with outdoor air.

Then, it is determined whether or not the heat pump system in the heating mode is switched to a cooling mode. In case that the heat pump system in the heating mode is switched to the cooling mode, a power supply to the compressor 2 is switched off so that the compressor 2 is stopped (S2 and S3).

Here, the heat pump system in the heating mode is switched to the cooling mode by a user's manipulation. Otherwise, in case that it is necessary to operate the heat pump system in a defrosting mode for removing frost generated on the surface of the outdoor heat exchanger 8 due to a low outdoor temperature when the outdoor heat exchanger 8 serves as the evaporator in the heating mode, the heat pump system in the heating mode is switched to the cooling mode.

Thereafter, it is determined whether or not a designated time (t) under the condition that the compressor 2 is stopped has elapsed. In case that the designated time (t) has elapsed, a power supply state supplied to the four-way valve 12 is changed, and then the four-way valve 12 changes the flow direction of the refrigerant (S4 and S5).

Here, when the compressor 2 is stopped, the flow of the

refrigerant is gradually stopped. Preferably, the designated time (t) is a time required to reduce the flow rate of the refrigerant passing through the four-way valve 12 to less than a designated rate when the compressor 2 is stopped.

Further, the designated time (t) may be a time required to allow the flow rate of the refrigerant passing through the four-way valve 12 to reach a value of zero (0) when the compressor 2 is stopped.

Otherwise, without application of the designated time (t), it is possible to control the flow direction of the refrigerant to be changed by operating the four-way valve 12 when the flow rate of the refrigerant is reduced to less than the designated rate.

In case that the compressor 2 can be operated in a multi-stage manner, the operation of the compressor 2 is not stopped, but the operation of the compressor 2 is converted into a stage having a lower state than that of a stage at a point of time when the heat pump system is switched from the cooling mode to the heating mode or from the heating mode to the cooling mode so as to reduce the flow rate of the refrigerant. Then, the four-way valve 12 is operated so as to change the flow direction of the refrigerant.

Accordingly, when the compressor 2 is stopped so that the flow rate of the refrigerant is reduced and pressure imposed on the four-way valve 12 is reduced, the four-way valve 12 changes

the flow direction of the refrigerant. Here, when power is cut off, the four-way valve 12 changes the flow direction of the refrigerant so that the heat pump system is operated in the cooling mode, and when power is re-supplied, the four-way valve 12 changes the flow direction of the refrigerant so that the heat pump system is operated in the heating mode.

After the four-way valve 12 is operated so as to change the flow direction of the refrigerant as described above, the compressor 2 is re-operated in a normal state so that the heat pump system is operated in the cooling mode (S6).

Here, the refrigerant circulates along the compressor 2, the outdoor heat exchanger 8, the electronic expansion valve 6 and the indoor heat exchanger 4, sequentially. The outdoor heat exchanger 8 serves as a condenser, and the indoor heat exchanger 4 serves as an evaporator.

Fig. 4 illustrates graphs showing on/off states of the compressor 2 and the four-way valve 12 according to variation of time when the heating mode of the heat pump system is switched to the cooling mode. In the heating mode, power is supplied to the compressor 2 and the four-way valve 12 so that the heat pump system maintains its heating mode. When the heating mode of the heat pump system is switched to the cooling mode, a power supply to the compressor 2 is cut off by a cooling switching signal so that the compressor 2 is stopped.

After a designated time (t) from the above stoppage of the compressor 2 elapses so that the flow rate of the refrigerant is reduced, a power supply to the four-way valve 12 is cut off so that the flow direction of the refrigerant is changed. Then, power is re-supplied to the compressor 2 so that the switching of the heat pump system from the heating mode to the cooing mode is completed.

On the other hand, Fig. 5 illustrates graphs showing on/off states of the compressor 2 and the four-way valve 12 according to variation of time when the cooling mode of the heat pump system is switched to the heating mode. When the cooling mode of the heat pump system is switched to the heating mode, a power supply to the compressor 2 is cut off so that the compressor 2 is stopped. After a designated time (t') from the above stoppage of the compressor 2, power is supplied to the four-way valve 12 so that the flow direction of the refrigerant is changed. Then, power is re-supplied to the compressor 2 so that the switching of the heat pump system from the cooling mode to the heating mode is completed.

As apparent from the above description, the present invention provides a method for controlling cooling/heating of a heat pump system, which controls a compressor to be stopped so as to reduce and stop flow of a refrigerant when a cooling/heating mode of the heat pump system is switched, and controls a four-way valve to change a flow direction of the

refrigerant after a designated time from the stoppage of the compressor elapses, thus preventing the rapid change of the flow direction of the refrigerant and reducing noise generated during the cooling/heating mode switching. Accordingly, it is possible to increase reliability of heat pump system products.

Although the preferred embodiments of the present invention have been disclosed for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.